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A computational model of blood flow in normal and diseased arteries

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Obesity in children is quickly becoming one of the major challenges of the 21st century. The health risks such obese children and adolescents suffer from are increased levels of blood cholesterol, early signs of cardiovascular disease (CVD) and other serious health problems. Computational fluid dynamic methods can quantify disturbed blood flow mathematically and thus provide a more powerful approach to haemodynamic investigation.

The aim of this research project was to develop and apply a simplified model of an arterial segments for young normal-weight and obese patients, in order to analyse the effects of blood flow. By developing a mathematical model based on a 3-element Windkessel model, the haemodynamics of the arterial system in terms of resistance and compliance were defined. The model is adaptable for both children and adults and produces plots with output values for parameters such as blood pressure.

Throughout the study, flow-related disease markers - which provide an indication of cardiovascular disease (CVD) in an individual - were identified. The literature review compared obese and normal-weight children in terms of (1) systolic blood pressure, (2) pulse wave velocity, (3) baseline brachial flow-mediated vasodilation, and (4) carotid intima-media thickness and stiffness. All four of these disease markers were found to have greater values in obese children than normal-weight children – indicating presence or onset of CVD.

The research undertaken in this study provides a greater understanding of blood flow in obese and normal-weight children while the mathematical model provides a quantitative representation of blood flow for any individual.

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